DOCUMENT RESUME

ED 409 268 SP 037 364

AUTHOR Mills, Brett D.; And Others
TITLE Lab Exercises for Kinesiology.
INSTITUTION United States Sports Academy, Daphne, AL.
PUB DATE Apr 97
NOTE 78p.
PUB TYPE Reports - Descriptive (141)
EDRS PRICE MF01/PC04 Plus Postage.
DESCRIPTORS *Athletics; *Biomechanics; *Exercise; Exercise Physiology; Higher Education; Motor Reactions; *Musculoskeletal System; Physical Activities; Physical Education; Psychomotor Skills; *Skill Development; Teaching Methods
IDENTIFIERS *Kinesiology; *Mechanical Kinesiology

ABSTRACT

This monograph presents descriptions of various exercises and athletic activities with a kinesiological and biomechanical analysis of the muscle systems involved. It is intended as examples of laboratory activities and projects in a college course in kinesiology. A listing of the required laboratory exercises precedes the examples. Specific activities analyzed include: seated row exercise, right-handed baseball bat swings, instep shoelace soccer kick, right-legged soccer kick. Additionally, a strength training, conditioning, and testing program for team handball is detailed including skill tests and a training schedule for both off-season and in-season phases. An example of required student assignments involving videofilming four specific skills from four different sports with a review of the literature and kinesiological and biomechanical analysis of each is also provided. The sports skills analyzed are: (1) the long snap (football), (2) the roundhouse kick (karate), (3) the vertical jump (basketball, volleyball, track and field), and (4) rope jumping (general conditioning). (Contains 182 references.) (JLS)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

Lab Exercises for Kinesiology

ED 409 268

Brett D. Mills
Chris D. Grabowski
Tim R. Boudreaux
Deborah A. Young
Aaron J. Flugum

United States Sports Academy

April, 1997

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☐ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL HAS BEEN GRANTED BY

B. Mills

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

BEST COPY AVAILABLE

SP037364

Lab #1	Write a kinesiological analysis of a weight strengthening exercise. There is an example in your lab book (seated row).
Lab #2	Write a kinesiological analysis of a sport skill where the foot is being used. There is an example in your lab book (soccer kick).
Lab #3	Write a kinesiological analysis of any sport skill you choose. Examples are in your lab book.
Lab #4	Design a strength training and testing program for any sport. The use of both biomechanical and kinesiological principles should be evident in your program. There is an example in your lab book (team handball).
Project	Each student is required to film four specific sport skills and each skill must be from a different sport. Once each of the four sport skills have been recorded the student is required to write a kinesiological and biomechanical analysis of each skill (similar to the one's completed in lab), describe how an athlete would train to increase the performance of the sport skill (from a kinesiological/biomechanical standpoint), and describe what biomechanical testing procedures could be used to determine if performance has increased as a result of training. The video must be turned in with the paper. Be sure to follow the APA five chapter format. An example is in your lab book.

ANALYSIS OF SEATED ROW EXERCISE

DESCRIPTION:

The subject straddles the bench with chest positioned against padded vertical support. Chin should be above the padded support to align spine in neutral position. Feet should be flat on the floor or the step provided. Subject should outstretch arms and grasp the vertical hand grips or handles with palms facing and arms fully extended. Exhale as you pull your elbows in line with the sides of your body. Your elbows will end up slightly beyond your torso. As you near the end range, pull the shoulders and elbows to the rear as far as possible. Inhale as you return the bar to the initial position. This movement should be smooth and under control while still maintaining proper spine position.

ANALYSIS:

The seated row is divided into three phases and helps to develop almost all the muscles in the back region. The first phase of the seated row is the initial pulling of the weight to the body. The second phase is the exaggerated retraction of the shoulders, peak-contraction, and the final phase is the returning of the weight to starting position.

INITIAL PULLING OF THE WEIGHT TO THE BODY:

SHOULDER (POSTERIOR SURFACE)

Shoulder joint extension:
- assisted by Deltoid
- Latissimus Dorsi
- Teres Major
- Teres Minor
- Infraspinatus

Shoulder girdle adduction and depression:
- Lower Trapezius
- Rhomboids
- Pectoralis Minor

HAND AND WRIST

flexion:
- flexors of the hand and wrist

BACK

Retraction:
- Latissimus Dorsi

- Teres Major
- Rhomboids

ELBOW

Flexion:
- Biceps Brachii
- Brachialis
- Brachioradialis

CHEST

Retraction:
- Lower Pectoralis Major

ABDOMINAL

Stabilization:
- External Oblique
- Internal Oblique
- Rectus Abdominal

EXAGGERATED PEAK-CONTRACTION

BACK

Downward rotation and adduction of scapula:
- Upper Latissimus Dorsi
- Rhomboids
- Middle Trapezius
- Teres Major

ABDOMINAL

Isometric contraction:
- Rectus Abdominal
- External Oblique
- Internal Oblique

RETURNING TO INITIAL STARTING POSITION

SHOULDER

Shoulder joint flexion:
- deltoid

Shoulder girdle abduction and elevation:
- Serratus Anterior
- Trapezius

HAND AND WRIST

Eccentric flexion:
- flexors of the hand and wrist

BACK

Protraction:
- Latissimus Dorsi
- Teres Major
- Rhomboids
- Trapezius

ARMS

Flexion:
- Triceps

ABDOMINAL

Stabilization:
- Rectus Abdominal
- External Oblique
- Internal Oblique

ANALYSIS OF THE RIGHT HANDED BASEBALL BAT SWING #1

Design and analysis:

The baseball swing can be divided into four main phases. The first phase is the stance. The right handed batter stands perpendicular to the pitcher with legs slightly flexed and feet shoulder width apart. The batter holds the up making sure both elbows are near a horizontal position. The weight of the batter is slightly off center towards the right side. The bat is held with the arms flexed and abducted. The stride phase is characterized by the shifting of the majority of the batters weight from the left side to the right side. During the swing phase, the batter shifts his weight from right to left and swings the bat in a horizontal plane. The final phase, the follow through, begins after the ball is hit. The batter rotates the forarms and begins to decelerate the bat.

Stance Phase

The ankle
- Slight Dorsiflexion (eccentric to isometric contraction)
  - Gastrocnemius
  - Soleus
  - Tibialis posterior
  - Peroneus longus
  - Peroneus brevis

The knee
- Slight Flexion (eccentric to isometric contraction)
  - Vastus lateralis
  - Vastus mediali
  - Rectus femoris
  - Vastus intermedis

The hip
- Slight flexion (eccentric to isometric contraction)
  - Gluteus maximus
  - Biceps femoris
  - Semitendinosus
  - Semimembranosus

The trunk
- Slight flexion (eccentric to isometric contraction)
  - Erector spinae

The right glenohumeral joint
- Abduction (concentric to isometric)
  - Deltoid

Supraspinatus

The right shoulder girdle
Stabilized
middle and lower trapexzius
Romboideus

The right elbow joint
Flexion (concentric to isometric contraction
Brachialis
Brachioradialis
Biceps brachii
Pronator teres

The right radial ulnar joint
neutral position (concentric to isometric contraction)
Brachioradialis

The hands and wrist joints
flexion (concentric contraction)
Flexor carpi radialis
Flexor carpi ulnaris
Palmaris longus

The left shoulder girdle
Abduction (concentric to isometric)
Serratus anterior
Pectoralis minor

The left glenohumeral joint
Horizontal adduction (concentric to isometric)
Pectoralis major
Anterior deltoid

The left wrist
Slight pronation (concentric to isometric)
Pronator teres
Pronator quadratus

The neck
Left rotation
Sternocleidomastoid
Erector spinae
Suboccipital

The Stride Phase

The right ankle
- Dorsiflexion (isometric)
  - Gastrocnemius
  - Soleus
  - Tibialis posterior
  - Peroneus longus
  - Peroneus brevis

The right hip
- Adduction (concentric)
  - Adductor magnus
  - Adductor brevis
  - Adductor longus

The right knee
- Slight Flexion (isometric)
  - Vastus lateralis
  - Vastus medialis
  - Rectus femoris
  - Vastus intermedis

The left ankle
- Plantar flexion and foot inversion (concentric)
  - Gastrocnemius
  - Soleus
  - Peroneus brevis
  - Peroneus longus
  - Tibialis posterior
  - Tibialis anterior (inversion)
  - Flexor digitorum (inversion)

The left hip
- Abduction and flexion (concentric)
  - Gluteus medius
  - Gluteus minimus
  - Tensor fasciae latae
  - Satorius (flexion)
  - rectus femoris (flexion)
  - pectineus (flexion)
  - Illiopsoas (flexion)

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

The upper body and trunk remain the same as found in the stance phase.

The Swing Phase

The right ankle and foot

Plantar flexion and eversion (concentric)

Gastrocnemius

Soleus

Tibialis posterior

Peronius longus

Peronius brevis

Peronius tertius

The right knee joint

Extension (concentric)

Vastus lateralis

Vastus medialis

Vastus intermedis

Rectus femoris

The right hip

Internal rotation (concentric)

Pectineus

Gracilis

Semitendinosis

Semimembranosus

Gluteus minimus

Gluteus medias

The left ankle and foot

Dorsiflexion to neutral (eccentric)

Gastrocnemius

Soleus

Peroneus longus

Peroneus brevis

[redacted]
[redacted]
[redacted]
[redacted]
[redacted]
[redacted]
[redacted]

[redacted]
[redacted]
[redacted]
[redacted]
[redacted]
[redacted]
[redacted]

The right glenohumeral joint
Horizontal adduction (concentric)
Pectoralis major
Anterior deltoid
Coracobrachialis

The right shoulder girdle
Protraction
Pectoralis minor
Serratus anterior

[redacted]
[redacted]
[redacted]
[redacted]
[redacted]

The right and left wrist
Adduction
Flexor carpi ulnaris
Flexor carpi radialis

The left and right elbows
Extension
Triceps
Anconeus

The left glenohumeral joint
Horizontal abduction
Infraspinatus
Teres minor
Deltoid
Posterior fibres
subscapularis

The left shoulder girdle
Retraction
Trapezius
Rhomboids

The trunk
Left lateral rotation
Right external obliques
Left internal obliques

The Follow Through Phase

The right foot
Plantar flexion and eversion
Gastrocnemius
Soleus
Tibialis posterior
Peroneus longus

Peroneus brevis
Peroneus tertius

The right knee
slight flexion
Semitendinosis
Semimembranosis
Biceps femoris
Sartorius
Gracilis
Popliteus

The right hip
Internal rotation
Gluteus minimus
Gluteus medius
Pectineus

Semitendinosis
Semimembranosis
Gracilis
Tenso fascia latae

The left foot
neutral position

The left knee
Slight flexion
Semitendinosis
Semimembranosis
Biceps femoris
Sartorius
Gracilis
Popliteus

The left hip
External rotation
Iliopsoas
Biceps femoris
Six deep rotators
Gluteus maximus

The right glenohumeral joint
Horizontal adduction
Pectoralis major
Anterior deltoid
Coracobrachialis

The right shoulder girdle
Abduction (protraction)
Pectoralis minor
Serratus anterior

The right radial ulnar joing
Pronation
Pronator teres
Pronator quadratus

The right wrist
Adducts
Flexor carp ulnaris

The right and left fingers
- Flexion
  - Flexor carpi radialis
  - Flexor carpi ulnaris
  - Palmaris longus

The right and left elbow joints
- Flexion
  - Brachialis
  - Brachioradialis
  - Biceps brachii
  - Pronator teres

The left glenohumeral joint
- Horizontal Abduction
  - Subscapularis
  - Posterior deltoid
  - Teres minor
  - Infraspinatus

The left shoulder girdle
- Adduction
  - Rhomboids
  - Trapezius

The left forearm
- Supination
  - Supinator
  - Biceps brachii

The left wrist
- Flexion
  - Flexor carpi radialis
  - Flexor carpi ulnaris
  - Palmaris longus

ANALYSIS OF THE RIGHT HANDED BASEBALL SWING #2

DESCRIPTION:

The baseball swing is a very complex and precise activity to master. It is sometimes considered the most difficult task to perform in the game of baseball. The first portion of the movement is to properly grip the baseball bat. The hands should be gripped around the bat comfortably. The bat should be held in the fingers, not the palms. During the stance the subject must maintain good balance be positioned in a comfortable and relaxed flexed knee position. The right arm must be cocked back and held horizontally to the ground. The left arm must be horizontally adducted across the body. The bat should still be kept comfortably gripped between the fingers. The head should stay in the same position throughout the stance, stride, and swing phase of the hit. During the stride phase, the batter keeps hands and weight back. It is important to stay in this position and wait for the ball. The subjects shoulders and hips should also be back about 2 inches and more of the body weight should transfer to the back leg. The hands should be cocked back, not up or down. The move of the left leg in this phase should be low, light, and short. The inside of the big toe should land plantar flexed first. The swing phase is the explosion of the hands towards the ball. This is the most powerful movement in the complete action. Leverage is a important aspect for good control of the bat and gaining bat speed. At the start of the swing your head should be down, eyes on the ball, chin tucked and on your front shoulder. The front arm straightens (extends) with the rear elbow remaining bent and close to your body. Your body weight transfers from the rear leg to the front leg as your hips explode open. The rearfoot pivots on its ball to allow the hips to open. As the bat drives through, the weight transfers further over your braced front leg, while your rearfoot continues to pivot. The arms should extend and your eyes should continue to look down. After the ball is hit, your wrists roll over and allows the bat to complete its swing and end up over the front shoulder. The hips and shoulders have rotated explosively around the axis of the body and the rearfoot is fully pivoted up on the ball of the foot. The rearfoot should remain in the same position throughout the swing.

ANALYSIS:

The baseball hit is broken down into five different phases: 1) the grip (gripping the bat in the hands with arms outstretched in front of the body), 2) the stance, 3) the stride, 4) the swing, and 5) the follow through. These parts must be perfected as a whole movement to achieve quality control and power during the baseball swing.

GRIP

Hand and Wrist

Flexion of fingers and thumb:
- flexor digitorum superficialis
- flexor digitorum profundus
- flexor pollicis longus

Flexion of wrist:
- flexor carpi radialis
- flexor carpi ulnaris
- palmaris longus

Arms

Isometric contraction:
- brachioradialis

STANCE

Hand and Wrist

Right wrist extension:
- extensor carpi ulnaris
- extensor carpi radialis longus
- extensor carpi radialis brevis
- extensor digitorum

Left wrist flexion:
- flexor carpi radialis
- flexor carpi ulnaris
- palmaris longus

Elbow

Flexion:
- bicep brachii
- brachioradialis
- brachialis

Shoulder

Left shoulder horizontal adduction:
- deltoid
- coracobrachialis
- pectoralis major

Right shoulder abduction:

- deltoid
- pectoralis major
- supraspinatus

Trunk

Stabilization:
- rectus abdominis
- external oblique
- internal oblique

Back

Stabilization:
- erector spinae
- latisimus dorsi
- trapezius
- rhomboids
- teres major

Hips

Stabilization:
- gluteus maximus
- gluteus medius

Flexion:
- iliopsoas
- sartorius
- rectus femoris
- tensor fascia latae
- pectineus

Knees

Flexion:
- bicep femoris
- sartorius
- semitendinosis
- semimembranosus
- gracilis
- popliteus
- gastrocnemius

STRIDE

Feet

Left foot plantar flexion:
- gastrocnemius
- soleus
- tibialis posterior
- flexor digitorum longus
- flexor hallucis longus
- peroneus longus
- peroneus brevis

Plantar flexion of big toe:
- flexor hallucis longus

Left foot inversion:
- tibialis posterior
- flexor digitorum longus
- flexor hallucis longus

Knees

Flexion:
- bicep femoris
- sartorius
- semitendinosis
- semimembranosus
- gracilis
- popliteus
- gastrocnemius

Hip

Flexion:
- iliopsoas
- sartorius
- rectus femoris
- tensor fascia latae
- pectineus

Right adduction:
- pectineus
- adductor brevis
- adductor longus

- adductor magnus

- gracilis

Left Abduction:
- gluteus medius
- gluteus minimus
- tensor fascia latae

Lumbar spine

Right lateral flexion:
- internal oblique
- external oblique

Trunk

Stabilization:
- rectus abdominis
- external oblique
- internal oblique

SWING

Hand and Wrist

Left wrist extension:
- extensor carpi radialis brevis
- extensor carpi radialis longus
- extensor carpi ulnaris

Elbow

Extension:
- tricep
- anconeus

Shoulder

Right arm horizontal adduction:
- deltoid
- coracobrachialis
- pectoralis major

Scapular protraction:
- pectoralis minor
- seratus anterior

Trunk

Rotation:
- external oblique

- internal oblique

Stabilization:
- rectus abdominis

- Hip

Internal rotation of right hip:
- semitendonosis
- semimembranosis
- pectineus
- gracilis
- gluteus medius

External rotation of left hip:
- iliopsoas
- gluteus medius
- gluteus maximus
- piriformis
- bicep femoris

Knee

Left knee extension:
- rectus femoris
- vastus lateralis
- vastus intermedius
- vastus medialis

Foot

Right foot plantar flexion:
- gastrocnemius
- soleus
- tibialis posterior
- flexor digitorum longus
- flexor hallucis longus
- peroneus longus
- peroneus brevis

Plantar flexion of big toe:
- flexor hallucis longus

Right foot inversion:
- tibialis posterior
- flexor digitorum longus

- flexor hallucis longus

FOLLOW THROUGH

Hand and Wrist

Right wrist pronation:
- pronator teres
- pronator quadratus

Left wrist extension:
- extensor carpi radialis brevis
- extensor carpi radialis longus
- extensor carpi ulnaris

Left wrist supination:
- supinator

Left forearm supination:
- bicep brachii

Shoulder

Right shoulder horizontal adduction:
- deltoid
- coracobrachialis
- pectoralis major

Elbow

Flexion:
- bicep brachii
- brachialis
- brachioradialis

Trunk

rotation:
- internal oblique
- external oblique

Hips

Extension of right hip:
- gluteus maximus
- bicep femoris
- semitendinosis
- semimembranosis

Flexion of left hip:
- iliopsoas
- sartorius
- rectus femoris
- tensor fascia latae
- pectineus

Ankle and Foot

Plantar flexion:
- gastrocnemius
- soleus
- tibialis posterior
- flexor digitorum longus
- flexor hallucis longus
- peroneus longus
- peroneus brevis

THE INSTEP SHOELACE SOCCER KICK

Design and Analysis:

The kicker is in a position to the kick. The kick is made with the right foot while the left foot is planted. The kick is broken down into three phases. These phases are the approach, the contact, and the follow through. Each phase is analyzed kinesiologically.

The Approach Phase

Right ankle and foot
- Plantar flexion
  - Gastrocnemius
  - Soleus
  - Tibialis posterior
  - Flexor Hallucis longus
  - Flexor digitorum longus
  - Peroneus longus
  - Peroneus brevis
  - Peroneus tertius

Right knee
- Flexion and slight external rotation
  - Semitendinosis
  - Semimembranosis
  - Biceps femoris
  - Popliteus
  - Sartorius
  - Gracilius
  - Iliopsoas (external rotation

Right hip
- Extension and external rotation
  - Semimebranosis
  - Semitendinosi
  - Biceps femoris
  - Gluteus maximus
  - Gracilius
  - Sartorius
  - Pectineus
  - Iliopsoas
  - Adductor brevis
  - Adductor longus
  - Six deep rotators

Left ankle and foot
neutral could be slightly plantar flexed

Left knee
Slight knee flexion (eccentric to isometric contraction)
Vastus lateralis
Vastus medialis
Vastus intermedi
Rectus femoris

Left hip
Stabilizing (isometric)
hip extensors
hip flexors

Right shouder girdle and glenohumeral joint
Stabilized with arm at the side

Left glenohumeral joint
Horizontal adduction
Pectoralis major
Anterior deltoid
Coracobrachialis
Biceps brachii (hold shoulder flexed)

The Contact Phase

Right ankle
Plantar flexion
Gastrocnemius
Soleus
Peroneus longus
Peroneus brevis
Flexor hallucis longus
Flexor digitorum longus
Tibialis posterior

Right knee
Extension and internal rotation
Vastus lateralis
Vastus medialis
Vastus intermedis
Rectus femoris

Gluteus medius
Gluteus minimus

Right hip
Flexion
Rectus femoris
Iliopsoas
Pectineus
Sartorius
Tensor fascial latae

Trunk
Stabilization
Rectus abdominus
External obliques
Internal obliques
Erector spinae

Left glenohumeral joint
Horizontal abduction
Teres minor
Posterior deltoid
Infraspinatus

Left shoulder girdle
Adduction
Trapezius
Rhomboids

The Follow Through Phase

Right knee
Extension
Rectus femoris
Vastus lateralis
Vastus medialis
Vastus intermedis

Right hip
Flexion
Iliopsoas
Sartorius
Rectus femoris
Tensor Fasciae latae

Left knee
- Extension
  - Rectus femoris
  - Vastus lateralis
  - Vastus medialis
  - Vastus intermedius

Left ankle
- Plantar flexion
  - Gastrocnemius
  - Soleus
  - Peroneus longus
  - Peroneus Brevis
  - Flexor digitorum longus
  - Flexor hallucis longus

Left hip
- Extension
  - Semimembranosis
  - Semitendinosis
  - Biceps femoris

Left glenohumeral joint
- Horizontal abduction
  - Posterior deltoid
  - Infraspinatus
  - Teres minor

Right glenohumeral joint
- Extension
  - Latissimus dorsi
  - Teres major
  - Teres minor
  - Infraspinatus
  - Subscapularis

RIGHT-LEGGED SOCCER KICK

DESCRIPTION

The soccer kick that we were analyzing was called the instep pass. This pass is used primarily for kicking the ball 25 yards or more. To execute the instep pass, approach the ball from a slight angle. Plant your nonkicking foot (left foot in this case) beside the ball with slight flexion at the knee. This leg is primarily used for balance. This foot should be pointed in the direction of the target, either another person, or the goal. The subjects shoulders should also be squared to the target. The kicking leg (right leg in this case) is drawn back to prepare for execution. Knee of kicking leg is positioned over the ball. The kicking foot should be extended down and firmly positioned as the ball is contacted. To assist in balance, the arms should be slightly abducted. Keep the head down and focused on the ball throughout the entire movement. When you get ready to contact the ball transfer body weight forward and increase forward motion of kicking leg. Contact the center of the ball while maintaining firm position of kicking foot. Momentum should be carried through the ball. The weight is now centered over the ball of the balance foot (left foot). A complete follow-through motion should bring the kicking leg to waist level or higher.

ANALYSIS

The soccer kick, or pass is initiated about 80% of the time in soccer. This shows the importance of proper execution and technique. The soccer kick is broken down into three phases. The first phase is the approach towards the ball. The second phase is the contact, and the final phase is the follow-through.

APPROACH

Torso

Left trunk rotation:
- external oblique
- internal oblique

Stabilization:
- rectus abdominis
- external oblique
- internal oblique

Hip

Left hip flexion:
- iliopsoas
- pectineus
- rectus femoris
- sartorius
- tensor fascia latae

Right hip extension:
- gluteus maximus
- bicep femoris
- semitendinosus
- semimembranosus

Knee

Left knee flexion:
- gastrocnemius
- sartorius
- bicep femoris
- semitendinosus
- semimembranosus
- gracilis

Head

Flexion:
- sternocleidomastoid

Shoulder

Extension of left shoulder:
- pectoralis major
- anterior deltoid

Horizontal abduction of left shoulder:
- infraspinatus
- teres minor
- middle deltoid
- posterior deltoid

Elbow

Flexion of left elbow:
- bicep brachii
- brachialis
- brachioradialis

Ankle and Foot

Plantar flexion of right foot:
- soleus
- gastrocnemius
- peroneus longus
- tibialis posterior
- flexor hallucis longus
- flexor digitorum longus
- peroneus brevis

CONTACT

Torso

Right trunk rotation:
- external oblique
- internal oblique

Stabilization:
- rectus abdominis
- internal oblique
- external oblique

Shoulder

Horizontal abduction of left shoulder:
- infraspinatus
- teres minor
- middle deltoid
- posterior deltoid

Hip

Flexion of right hip:
- iliopsoas
- pectineus
- rectus femoris
- sartorius
- tensor fascia latae

Ankle and Foot

Plantar flexion of right foot:
- soleus
- gastrocnemius

- peroneus longus
- tibialis posterior
- flexor hallucis longus
- flexor digitorum longus
- peroneus brevis

Stabilization of left leg:
- gluteus maximus
- rectus femoris
- vastus lateralis
- vastus medialis

Inversion of right ankle:
- tibialis anterior
- tibialis posterior
- flexor digitorum longus
- flexor hallucis longus

Extension of toes on right foot:
- extensor digitorum longus
- extensor hallucis longus

Knee

Extension of right knee:
- rectus femoris
- vastus lateralis
- vastus medialis
- vastus intermedius

FOLLOW-THROUGH

Knee

Extension of right knee (eccentric flexion due to deceleration):
- bicep femoris
- semiteninosus
- semimembranosus

Flexion of left knee:
- rectus femoris
- vastus lateralis
- vastus medialis
- vastus intermedius

Hip

Flexion of right hip (eccentric extension due to deceleration):
- gluteus maximus
- bicep femoris
- semitendinosus
- semimembranosus

Inward rotation of right hip:
- gluteus minimus
- gluteus medius
- tensor fascia latae

Extension of left hip:
- posterior adductor magnus
- bicep femoris
- gluteus maximus
- semitendinosus
- semimembranosus

Ankle and Foot

Plantar flexion of left foot:
- soleus
- gastrocnemius
- peroneus longus
- tibialis posterior
- flexor hallucis longus
- flexor digitorum longus
- peroneus brevis

Shoulder

Horizontal adduction of left shoulder:
- subscapularis
- pectoralis major
- deltoid
- bicep brachii
- coracobrachialis

Extension of right shoulder:
- deltoid
- infraspinatus
- teres minor
- long head of triceps

Elbow

Flexion of left elbow:

- biceps brachii
- brachialis
- brachioradialis

TEAM HANDBALL CONDITIONING AND TESTING PROGRAM

Team handball is a relatively uncomplicated team game with twelve players to a side where six court players and a goalie of one team oppose the same number from another team. The remaining five players may be substituted in from the side lines at center court at any time.

The object of the game is to throw the ball into the opponent's goal and defend ones own. Although the basic rules are similar to those of soccer, the ball is moved with the hands and the game is played on an area more similar to that of basketball. At either end of the playing area (40m by 20m) is a set of miniature soccer goals (2m by 3m). There is also a goal crease 6 meters in front of and around each goal which is the exclusive territory of the goalkeeper who may use any means he can to defend his goal.

Skill Tests

Most skill tests are drills where a score of some sort can be obtained on an individual as a measure of his ability in that task. The score of the tests may not be beneficial to the athlete, but it allows the athlete to practice the important skills to be successful in team handball.

Speed Pass

The purpose of the speed pass is to measure the speed with which a player can continue to pass and catch a handball. The athlete stands 20 ft. away from a wall and throws the ball overhand against the wall, catches the rebound, and continues to throw the ball for a specified amount of time. This will build both speed and hand-eye coordination.

Speed and Accuracy Throw

The purpose of this skill is to measure the speed and accuracy with which a player can make throws at a target.
As with the speed pass drill, the athlete throws the ball against the wall. This time though, three circles are drawn, each one bigger than the other, as in the form of a bulls-eye. The smaller the circle hit, the more points allotted an so on. Also, the athlete would benefit from a ball that is thrown at a higher velocity.

Agility Dribble

The purpose of the agility dribble is to measure the speed with which a player can dribble a handball around obstacles. The athlete dribbles a handball around a designated number of obstacles while being timed. This test is performed a number of times to evaluate the athlete's improvement over a specified amount of time.

Interval Running

The purpose of interval running is to measure endurance in speed. The athlete sprints 20 yds. and then walks back to the starting line. After 30 sec. the athlete sprints and walks back again. This is repeated a specified number of times. After engaging in the strength and conditioning program the athlete can then be evaluated to see how credible the program is.

Strength and Conditioning Program

Physical conditioning is an important aspect of a high level of handball play. It allows a player to make faster gains in comparison to other aspects of training. Handball is a game where running speed and endurance while moving forward, sideward and backward are essential. It requires leg and arm strength for jumping and harder shots on goal.
Other important physical attributes are power, finesse, and control.

The strength and conditioning program has three phases:
1) Off-season, 2) Pre-season, and 3) In-season.

Off-season Phase

The Off-season phase of the conditioning program begins one month after the season and ends eight weeks before it begins. The athlete's specific weaknesses are concentrated on at this time along with increasing overall strength.

Free weights may be used during this phase for strength gains. Medicine balls, rope climbing, and push-ups are also used during this phase. Also, there is an emphasis on manual resistive exercise.

An example of an Off-season program may be:

CHEST:	Bench Press 3x10	BACK:	Pull-ups 3x10
	Flyes 3x10		Rope Climbing
	Push-ups 3x25		-3 sets within a certain time limit
			Bent Over Row 3x10
LEGS:	Squats 3x10	SHOULDERS:	Military Press 3x10
	Leg Press 3x10		Lateral Raise 3x10
	Leg Extensions 3x15		Dumbbell Press 3x10
	Leg Curls 3x15		Shoulder Shrugs 3x10
	Calf Raises 3x25		

ARMS: Barbell Curls 3x10
Dumbbell Curls 3x10
Lying Extensions 3x10
Tricep Pushdowns 3x10

The objective of this program is to prepare the athlete for the Pre-season phase. Sets and repetitions are kept around 3x10 because the athlete is trying to build endurance not bulk. Medicine ball exercises can be inserted into the program to work the athlete's trunk mobility. The skill tests can be performed during this phase and then again during the pre-season phase to access how effective the conditioning program is.

Pre-season Phase

The pre-season phase of the conditioning program is geared towards agility, speed and power. Sport specific skills are used to during this phase to enhance the cardiovascular and endurance levels of the athlete. A general conditioning program is used during this phase.

Push-ups
Sprints
Jumping rope
Medicine ball

Sport Specific:
Passing drills
Speed Pass
Speed and Accuracy Throw
Agility dribble
Interval Running

In-season Phase

During the In-season phase, the sport specific activities are mainly concentrated on, especially the skill tests. The object is that the athlete stays in shape during the season by not being overworked. The condition that the athlete is in during the season indicates how effective the overall strength and conditioning program is and also determines what the athlete needs to concentrate on during the off season.

Sport Specific:
Passing drills
Speed Pass
Speed and Accuracy Throw
Agility Dribble
Interval Running

BIOMECHANICAL AND KINESIOLOGICAL ANALYSIS OF THE LONG SNAP, ROUNDHOUSE KICK, VERTICAL JUMP, AND ROPE JUMP

CHAPTER I

INTRODUCTION

The importance of research involving kinesiological and biomechanical analysis of sports skills is beyond description. Without advancements in these areas sports performances would not have progressed at such incredible rates as have been seen in recent years. Using proper biomechanics in the performance of sports skills have allowed many athletes to increase their performances as well as decrease the chances of injury which may result from improper mechanics. Research seems to be lacking in some specific areas within certain sports.

The purpose of the present study is to provide a thorough kinesiological analysis as well as a partial biomechanical analysis of four specific sport skills in order to provide support and possibly opposition to present research. The skills which will be analyzed are: the football long snap, rope jumping, the karate roundhouse kick, and the vertical jump. Biomechanics is the science concerned with the internal and external forces acting on the human body and the effects of these forces (Hay, 1993).

The purpose of this study is not to provide an all inclusive biomechanical analysis. Only a few of the many important biomechanical concepts will be analyzed as they relate to these specific sport skills.

Statement of the problem

Research is limited on the kinesiological and biomechanical analysis of some specific sports skills. Sports such as karate and jump roping are not analyzed in research quite as often as football or vertical jumping.

Significance of the problem

As mentioned earlier, research in biomechanics is partly responsible for the advancement of performances in sporting events. A lack of research in an area of sports limits the advancement of that sport. More research in specific sports will enable athletes to become more efficient in their movements which may translate to enhanced performance.

Limitations

One possible limitation to this study may be the angle in which the skill was filmed. The angle used was one in which the majority of the bodies joints could be seen.

Research Hypothesis

The brief kinesiological and biomechanical analysis of the football long snap, the karate roundhouse kick, the vertical jump, and jump roping will reinforce existing research as well as introduce new findings.

CHAPTER II

REVIEW OF LITERATURE

Long Snap

The "star" quarterback, the "talented" running back, the "hard hitting" linebacker- the most noticeable players on the football field. However, two of the most important players on a football team who can dictate a shift in the team's momentum are the punter and the long snapper. If the snap from the center to the punter is not fast and accurate, the punter will have a difficult time punting the ball, or worse yet, the punt may end up being blocked or even fumbled. On the other hand, a perfect snap and punt can help the team's defensive unit by putting the opposing team in terrible field position.

Ohton(1988) conducted a study on proper kinesiological and biomechanical aspects of a successful long snap. He described that an accurate and fast snap depends on the sequence of movements from the snapper in deep punt formation. It is the coach's responsibility to analyze the proper form of the snap while the player needs to have an understanding of what he is learning. By working together and practicing the proper technique, the chance for error is greatly diminished.

Roundhouse Kick

The roundhouse kick is on of the most exciting movements in karate. It is used in competitions and for self-defense. It requires speed, skill, and flexibility of the entire body. It is a kick that generates a tremendous amount of power and it significantly decreases the distance between yourself and your opponent. Every muscle of the body is used throughout the entire movement, therefore requiring a sound training program that works entire body. Hobusch & McClellan(1990) described the application of the roundhouse kick to the opponent's head using the rear leg, with the attacker decreasing the distance and contact being made with the instep of the foot.

They provided a biomechanical and kinesiological analysis by explaining the five phases of the roundhouse kick: preparation for the attack, closing the gap between the kicker and attacker, the balanced position, the kick and the pull back. It is necessary that when learning how to perform the kick correctly, each of the five phases should be performed in a smooth continuous manner with the proper sequence, distance, timing and control, while gradually increasing speed as the athlete becomes more familiar with the movement.

Vertical Jump

The vertical jump is a vital movement in all sports, especially basketball, volleyball, and track and field. Being able to jump quicker and higher than your opponent gives you the advantage in pulling-down that important rebound, spiking the ball to win the final point in volleyball game or reaching new records in the high jump. It is an often overlooked movement in sports and one that is not difficult to train.

The entire body is worked throughout the jump with an emphasis on the leg muscles. The height of the jump will be determined is determined by the vertical velocity of the body's center of gravity(Appendix C) at the moment of takeoff (Semenick & Adams,1987). The jumper's aim then is to attain the greatest takeoff velocity. Semenick & Adams(1987) add that the taller jumper whose center of gravity is higher at the moment of takeoff will have a clear advantage since he or she will be able to project the center of gravity higher from the floor even when force generated is no greater than that attained by shorter players.

Rope Jumping

Over the past decade rope jumping has developed from a recreational exercise into conditional tool(Pirteli & O'Shea,1986). Brancazio(1984) described rope jumping as being a valuable method in developing upper an lower coordination as well as gross body equilibrium or balance, agility, rhythm, limb speed, and relative muscular endurance.

Other benefits of rope jumping are the improvements of the three energy systems: ATP-PC, Lactic Acid, Oxygen (Pitreli & O'Shea,1986). Depending on where it is included in the workout, rope jumping as a conditioning tool will enhance aerobic capacity and power, as well as anaerobic capacity.

Rope jumping can be used in any sport that demonstrates one of the following characteristics provided by Pitreli & O'Shea(1986):

1) Involves sudden omnidirectional changes during the course of movement.
2) Involves a brief period when contract is broken with a supportive surface either repetitively as in running or explosively as in jumping.
3) Involves eye-hand-foot coordination, or upper and lower extremity synchrony of the variety commonly found in sports where positioning and timing is critical.
4) Involves a ballistic "catapult or slingshot action" of the upper extremities, encountered in throwing events.
5) Involves the grasping of relatively light implements for long periods of time, under isometric or static conditions of a submaximal nature.
6) Involves postural or static and dynamic stabilization of both the upper and lower extremities, to defer fatigue and deter traumatic injury.
7) Involves the constant shifting of body weight, in a manner conductive to the maintenance of balance.
8) Involves the use of light implement under the conditions and/or criteria where the volume of strokes is high, such as that which occurs in racquet sports.

By following these guidelines, athletes can develop both a cardiovascular and muscularly-fit body to help them become more competitive in their chosen sport.

CHAPTER III

METHODS

Subjects

The two authors (male) of this paper served as subjects for this study (n = 2). The mean age was 24 years and both subjects had some experience, prior to the study, with the sports skills which were demonstrated. Each subject was assigned the skill in which he had the most experience in order to obtain the most accurate performance of that skill.

Instrumentation

A Panasonic VHS Palmcorder IQ x12 with x20 digital zoom and digital EIS stabilization was used to film the subjects performing the techniques. The skill was filmed from approximately a 45 degree angle from the line of intent in which the skill is designed and on the same horizontal plane. However, the horizontal angle from which the vertical jump was filmed was altered (approx. 20 degrees) in order to properly analyze the technique. A jump rope and football were also used when performing the appropriate skills.

Procedures

Each subject performed two of the four techniques (football long snap, rope jumping, karate roundhouse kick, and vertical jump) in compliance with previous knowledge of that skill. No stipulations were placed on the subjects concerning adjustments, or modifications in the performance of the techniques.

Design and Analysis

The subjects filmed at optimal angles which allowed for a complete and detailed kinesiological analysis. The biomechanical analysis concentrated only on specific portions of each technique. A complete biomechanical analysis is above and beyond the scope of this study.

CHAPTER IV

RESULTS

KINESIOLOGICAL ANALYSIS

Roundhouse Kick

Description:

The subject stands in a sparring stance with the left foot in front and the right foot in back. The hips are at a 45 degree angle to the right side of the facing target. The torso is also at a 45 degree angle to the right side of the target. The arms are slightly flexed at the shoulder joint and more so at the elbow joint. The subjects head is rotated slightly left from the body which is facing the target. The subject then pushes off with the right leg and foot which starts the body rotating on the left foot. The right knee is lifted up and completely flexed as the body starts to turn. At this point the right foot is plantar flexed. The right hip turns toward the target and the right knee is simultaneously extended. The torso remains as upright as possible throughout the motion. The instep of the right foot makes contact with the target.

Analysis:

This kick will be broken down into five separate steps for proper kinesiological analysis. The first phase is the preparation phase which consist of the stance of the subject before movement occurs. The next phase will be the push off. The next phase is the chamber which is when the knee is flexed to prepare for the extension. The fourth phase is the kick which is a forceful extension of the knee. The final phase will be the pull back which is immediate flexion of the knee after the foot makes contact with the target.

Preparation Phase

ANKLE
Dorsi Flexion
Contraction of plantar flexors of the ankle (isometric contraction).

KNEE
Flexion
Contraction of extensors of the knee (isometric contraction).

HIP
Flexion
Contraction of extensors of the hip (isometric contraction).

TORSO
Neutral
Extensors, flexors, lateral flexors (isometric contraction).

SHOULDER JOINT
Flexion
Contraction of flexors of shoulder joint (isometric contraction).

ELBOW
Flexion
Contraction of elbow flexors (isometric contraction).

WRIST
Neutral
Contraction of flexors and extensors (isometric contraction).

PHALANGES
Flexion
Contraction of flexors (isometric contraction).

Push Off Phase

ANKLE (RIGHT)
Plantar Flexion
Gastrocnemius (Conc. contr.)
Soleus (Conc. contr.)
Peroneus Longus (Conc. contr.)
Peroneus Brevis (Conc. contr.)

KNEE (RIGHT)
Extension
Rectus Femoris (Conc.)
Vastus Lateralis (Conc.)
Vastus Medialis (Conc.)
Vastus Intermedius (Conc.)

HIP (RIGHT)
Extension
Gluteus Maximus (Conc.)
Biceps Femoris (Conc.)
Semimembranosus (Conc.)
Semitendinosus (Conc.)

HIP (LEFT)
Medial Rotation
Gluteus Minimus (Conc.)
Gluteus Medius (Conc.)
Tensor Fasciae Latae (Conc.)

Chamber Phase

ANKLE (RIGHT)
Plantar Flexion
Plantar Flexors (isometric contraction)

KNEE (RIGHT)
Flexion
Biceps Femoris (conc.)
Semimembranosus (conc.)
Semitendiosus (conc.)
Sartorious (conc.)
Gracilis (conc.)
Popliteus (conc.)
Gastrocnemius (conc.)

HIP (RIGHT)
Flexion
Psoas Major (conc.)
Iliacus (conc.)
Pectineus (conc.)
Rectus Femoris (conc.)
Tensor Fascia Latae (conc.)
Sartorius (conc.)
Gracilis (conc.)
Gluteus Minimus (conc.)
Gluteus Medius (conc.)

TORSO
Lateral Flexion (right)
External Oblique (right conc.)
Internal Oblique (right conc.)

SHOULDER JOINT (RIGHT)
External Rotation
Infraspinatus (conc.)
Teres Minor (conc.)

SHOULDER JOINT (LEFT)
Internal Rotation
Latissimus Dorsi (conc.)
Teres Major (conc.)
Pectoralis Major (conc.)
Subscapularis (conc.)

Neck
Rotation (right)
Sternoclidomastoid (right)

Kick Phase

KNEE (RIGHT)
Extension
Extensors (forceful conc.)

HIP (RIGHT)
Flexion
Flexors (conc.)
TORSO
Rotation (right)
External Oblique (left conc.)
Internal Oblique (right conc.)

NECK
Rotation (right)
Sternoclidomastoid (right conc.)
Lateral Flexion (right)
Sternocleidomastoid (conc.)
Erector Spinae (conc.)
Three Scaleni (conc.)
Splenius Capitis (conc.)

Splenius Cervicis (conc.)

Pull Back Phase

KNEE (RIGHT)
Flexion
Flexors (conc.)

Vertical Jumping

Description:

The subject begins the vertical jump in a relaxed standing position. The subject will then lower the center of gravity by flexing the knees. The shoulder joints are simultaneously hyperextended. The subject will then forcefully extend the knees and plantar flex the ankles to propel the center of gravity upward. The shoulder joints are simultaneously flexed to assist in achieving upward momentum. The subject will then fully flex the right shoulder and elbow joint and reach as high as possible. As the athlete lands he will absorb the impact by eccentrically flexing the knees and ankles.
analysis:

The vertical jump will be divided into four phase in order to properly evaluate its kinesiological aspects. The first phase is the preparatory phase which is characterized by a lowering of the center of gravity. The second phase will be the take off which is a forceful contraction of the knees and ankle joints. The next phase is the reach which occurs when the athlete is at the peak of the jump. The last phase is the landing which consist of eccentric contractions mainly of the knees and ankles.

Preparatory Phase

ANKLES
Dorsi Flexion
Gastrocnemius (eccen.)
Soleus (eccen.)
Peroneus Longus (eccen.)
Peroneus Brevis (eccen.)
Tibialis Posterior (eccen.)
Flexor Digitorum Longus (eccen.)
Flexor Hallucis Longus (eccen.)

KNEES
Flexion
Rectus Femoris (eccen.)
Vastus Lateralis (eccen.)

Vastus Medialis (eccen.)
Vastus Intermedius (eccen.)

HIPS
Flexion
Gluteus Maximus (eccen.)
Biceps Femoris (eccen.)
Semimembraosus (eccen.)
Semitendinosus (eccen.)

TORSO
Extension
Erector Spinae (isometric)

SHOULDER JOINTS
Hyperextension
Deltoid (posterior conc.)
Triceps Brachii (long head conc.)

CERVICAL SPINE
Extension
Erector Spinae (isometric)

Take Off Phase

ANKLES
Plantar Flexion
Plantar Flexors (see ankle for prep phase)(conc.)

KNEES
Extension
Extensors of knee (see knee for prep phase) (conc.)

HIPS
Extension
Extensors of hip (see hip for prep phase) (conc.)

SHOULDER JOINTS
Flexion
Deltoid (anterior conc.)
Pectoralis Major (upper fibers conc.)
Coracobrachialis (conc.)
Biceps Brachii (short head conc.)

Reach Phase

SHOULDER JOINT (RIGHT)
Flexion
Flexors of shoulder joint (see take off phase) (conc.)

SHOULDER GIRDLE (RIGHT)
Elevation
Levator Scapulae (conc.)
Trapezius (upper fibers conc.)
Rhomboid (conc.)
Upward Rotation
Trapezius (all fibers conc.)
Serratus Anterior (conc.)

SHOULDER GIRDLE (LEFT)
Deprssion
Trapezius (lower fibers conc.)
Pectoralis Minor (conc.)
Downward Rotation
Rhomboid (conc.)
Pectoralis Minor (conc.)

Landing Phase

ANKLES
Same as prep phase.

KNEES
Same as prep phase.

TORSO
Same as prep phase.

SHOULDER JOINTS
Extension
Flexors of shoulder (eccen.)

Rope Jumping

Description:

The subject will hold the ends of a rope at about waist level and begin turning. As the rope travels over the head and nears the feet the subject will jump about four inches above the ground and allow the rope to swing under the feet. The elbows, shoulders, knees, ankles, and hips will only move slightly.

Analysis:

This motion will be divided into three phases for proper kinesiological analysis. Phase one will be the load phase which begins at the point where the rope lies just over head and is on its downward path, and terminates at the point where the hip and knee joints extend. Phase two is the flight phase which begins at push off and continues through the brief period of non support. The third phase is the landing phase which begins just as the feet touch down and ends as the rope nears the top of the head which is where the load phase begins over again.

Load Phase

ANKLES
Dorsiflexion
Gastrocnemius (isometric)
Soleus (isometric)
Peroneus Longus (isometric)
Peroneus Brevis (isometric)
Tibialis Posterior (isometric)
Flexor Digitorum Longus (isometric)
Flexor Hallucis Longus (isometric)

KNEES
Flexion
Rectus Femoris (isometric)
Vastus Lateralis (isometric)
Vastus Medialis (isometric)
Vastus Intermedius (isometric)

HIPS
Flexion
Gluteus Maximus (isometric)
Biceps Femoris (isometric)
Semimembranosus (isometric)

Semitendinosus (isometric)

TORSO
Flexion
Erector Spinae (isometric)

SHOULDER JOINT
Extension
Deltoid (posterior conc.)
Triceps Brachii (long head conc.)
Outward Rotation
Infraspinatus (conc.)
Teres Minor (conc.)

ELBOW
Flexion
Biceps Brachii (conc.)
Brachialis (conc.)
Brachioradialis (conc.)

WRIST
Extension
Extensor Carpi Ulnaris (conc.)
Extensor Digiti Minimi (conc.)
Extensor Digitorum (conc.)
Extensor Indicis (conc.)
Extensor Pollicis Longus (conc.)
Extensor Carpi Radialis Brevis (conc.)
Extensor Carpi Radialis Longus (conc.)

Radial Flexion
Flexor Carpi Radialis (conc.)
Extensor Carpi Radialis Longus (conc.)
Extensor Carpi Radialis Brevis (conc.)
Extensor Pollicis Longus (conc.)
Abductor Pollicis Longus (conc.)

FOREARM
Supination
Supinator (conc.)
Biceps Brachii (conc.)
Brachioradialis (conc.)

PHALANGES
Flexion
Flexor Digitorum Profudus (conc.)
Flexor Digitorum Superficialis (conc.)
Flexor Pollicis Longus (conc.)

Flight Phase

ANKLES
Plantar Flexion
Same as load phase but conc.

Knees
Extension
Same as load phase but conc.

HIPS
Extension
Same as load phase but conc.

ELBOWS
Extension
Triceps Brachii (all three heads conc.)

WRISTS
Radial Flexion
Same as load phase
Extension
Same as load phase

Landing phase

ANKLES
Same as load phase but eccentric.

KNEES
Same as load phase but eccentric.

HIPS
Same as load phase but eccentric.

WRISTS
Maximal extension and radial flexion.

ELBOW
Same as load phase but conc.

SHOULDER
Same as load phase.

Long Snap

Description:

Athlete has feet planted farther than shoulders width apart and knees are slightly flexed. The hips and torso are fully flexed so that the back is below the horizontal. The neck is flexed so that the athlete is looking through his legs. Shoulders are flexed fully with hands out in front of the athletes head. The athlete then forcefully extends the shoulders which brings the hands through the legs at which point the football is released.

Analysis:

The long snap will be divided into three steps for further kinesiological analysis. The first step is the stance position which is a static position. The next phase is the acceleration phase which consist of forceful shoulder joint and elbow extension. The last phase is the release and deceleration phase.

Stance Position

ANKLES
Dorsi Flexion
Gastrocnemius (eccen.)
Soleus (eccen.)
Peronius Longus (eccen.)
Peronius Brevis (eccen.)
Tibialis Posterior (eccen.)
Flexor Digitorum Longus (eccen.)
Flexor Hallucis Longus (eccen.)

KNEES
Flexion
Rectus Femoris (eccen.)

Vastus Lateralis (eccen.)
Vastus Medialis (eccen.)
Vastus Intermedius (eccen.)

HIPS
Flexion
Gluteus maximus (eccen.)
Biceps Femoris (eccen.)
Semimembranosis (eccen.)
Semitendinosis (eccen.)

TORSO
Flexion
Iliocostalis Lumborum (eccen.)
Iliocostalis Cervicis (eccen.)
Erector Spinae (eccen.)

SHOULDER JOINT
Flexion
Anterior Deltoid (conc.)
Coracobrachialis (conc.)
Supraspinatus (conc.)
Adduction
Latissimus Dorsi (conc.)
Teres Major (conc.)
Medial Rotators (conc.)

ELBOW
Flexion
Triceps Brachii (eccen.)

WRIST
Neutral

Acceleration Phase

ANKLES
Plantar Flexion
Same as stance phase but conc.

KNEES
Extension
Same as stance phase but conc.

HIPS
Flexion
Psoas Major (conc.)
Iliacus (conc.)
Tensor Fascia Latae (conc.)
Rectus Femoris (conc.)

TORSO
Flexion
Rectus Abdominus (conc.)

SHOULDER JOINT
Extension
Latissimus Dorsi (conc.)
Posterior Deltoid (conc.)
Infraspinatus (conc.)
Teres Minor (conc.)

ELBOW
Extension
Triceps Brachii (conc.)

WRIST
Flexion
Flexor Carpi Radialis (conc.)
Flexor Carpi Ulnaris (conc.)

Release and Deceleration Phase

TORSO
Flexion
Iliocostalis Lumborum (eccen.)
Iliocostalis Cervicis (eccen.)
Longisimus Thoracis (eccen.)
Longisimus Cervicis (eccen.)
Longisimus Capitis (eccen.)
Spinal Thoracis (eccen.)

BIOMECHANICAL CONSIDERATIONS

Karate Roundhouse Kick

One of the most important biomechanical considerations involved in performing a proper roundhouse kick is Newton's Law of action reaction. The most forceful dimension within all five phases of the roundhouse kick is the delivery of the kick. During the delivery of the kick the hip is forcefully flexed as the knee is forcefully extended. The forces generated from this rigid action will inevitably cause a loss of balance unless this action is offset by an equal and opposite reaction. The equal and opposite reaction is produced primarily through a precise simultaneous contraction of the rectus abdominis, external obliques, and the internal obliques.

The other action partially responsible for off setting the action of the delivery is a shift in the pelvic girdle which involves complex forces and lines of action. The only contact with the ground is with the left foot which does not directly assist as a stabilizer for this action reaction couple. Therefore, this action reaction couple occurs practically in mid air which increases its difficulty. The inability to properly execute this action reaction couple can lead to a less effective kick or even injury.

Vertical Jump

One debate in vertical jump testing is whether to have the subject jump from a position in which the feet are planted or jump after a walking or running start. When an individual jumps with a horizontal velocity of zero (from a standing position with the feet planted) he or she is relying strictly on muscular contraction to produce vertical velocity. On the other hand, if the subject is allowed to walk or run immediately before jumping he or she is able to utilize horizontal velocity in the production of vertical velocity.

The best example of the conversion of horizontal velocity to vertical velocity is the approach of the high jumper. The high jumper utilizes the horizontal component of the approach to increase the vertical component of the jump. From a standing position a high jumper obviously could not clear near the heights he or she is capable of with a running start. Subjects involved in a vertical jump test should be able to score higher if a horizontal component is involved. Because of this factor the tester should be consistent with pre and post test measurements. If the standing position is used as a measurement, the same standing approach should be used throughout that subjects test.

Rope Jumping

There are four mechanical principles which can be applied to rope jumping: Principle of motion, principle of force, principle of balance and stability, and principle of projection (Pitreli & O'Shea, 1986). Six components of the principle of motion will be discussed. The first is the combination of rotary and translatory motion. Rope jumping requires the successful integration of turning the rope (rotary motion) and vertical

jumping (translatory motion). The continuous rotary motion of the rope is initiated and maintained by a coordinated effort of the shoulders, elbows and wrist which leads to the to the second component which is continuity of motion. The motions of the upper body which maintain the angular momentum of the rope must be steadily coordinated with the action of the lower body. Any hesitation of these motions will create problems in the total technique.

The next component is that of transfer of momentum. The arms create the rotary and vertical component. The momentum established by the shoulder, elbow, and wrist is transferred to the lower body to assist in accomplishing the vertical component.

The fourth component is the effect of momentum which addresses the fact that the momentum of the rope can be altered by manipulating either the mass or the velocity of the rope. If the momentum of the rope (specifically speed) is increased the effect the rope has as a result of ground contact will be less.

The next component is the principle of maximum acceleration and efficiency of motion. This applies to speed rope jumping when the maximum number of revolutions are accomplished in the shortest time. All available forces should be applied sequentially, with proper timing, and as directly as possible (Pitreli & O'Shea, 1986).

The last component of motion is that of the bodies effect of radius and rotational speed. The shoulder, elbow, and wrist can manipulate the rope in order to increase or decrease the radius of the rotary component. Shortening the radius will increase the speed and lengthening it will decrease the speed. These adjustments are needed to compensate for momentum variation resulting from the rope hitting the ground.

Long Snap

One of the major biomechanical consideration in the long snap is the shift in the center of gravity. In the stance position the center of gravity is slightly forward (on the body) because the ball is resting on the ground which provides some support. As the acceleration phase is initiated the center of gravity starts to shift back slightly. This has to occur, otherwise the athlete would fall on his face because the ball is no longer providing support. The center of gravity will reverse and start forward again when the hands pass between the legs until the release. This shifting in center of gravity is affected by numerous forces throughout the snap. Failure to balance the center of gravity may decrease the consistency of hitting the target which is the punter, or holder for the kicker.

CHAPTER V

DISCUSSION

Long Snap

The exercises performed for developing strength for the long snap should relate as closely as possible to the actual body movement for which the speed and velocity variables are needed. To train the muscles involved in the long snap, the strength training must be performed at an accelerating rate (Ohton,1988). Power and quickness exercises are commonly included in the training program.

The strength and conditioning program is divided into four phases; Post-season, Off-season, Pre-season and In-season.

POST SEASON: 8 Weeks Starting February

Goals: -Progressively build strength
-Concentrate on aerobic endurance
-Perform specific tests

MUSCULAR STRENGTH:

Four Core Exercises:	3 x Week
Power Clean	Weeks 1&2= 3x12 @75% 1RM
Bench Press(Incline)	Weeks 3-8= 3x6-8 @80% 1RM
Squat	
Shoulder Press	
Supplemental(Choose 2/Workout)	3x10-12
Lateral Raise	Bent Over Row
Shrugs	Arm Curls
Leg Curls	Lat Pulldown

**Always perform Neck Exercises(Manual/Partner Resistive)

ENERGY/CARDIOVASCULAR FITNESS:(Starting 5th or 6th Week)

AEROBIC(2 x Week)	ANAEROBIC(1 x Week)
Jog 880	2 x 40,60,100yd.sprints
4x440-Jog/Walk 220	(1 min. rest intervals)
Cardio/Endurance 1.5 mile run	
Jump Rope	Sled Pulls
Sit ups(3x90)	(4 sets/4x45lb.plates)
Push-ups(Max in 2 min)	

OFF-SEASON CYCLE: 12 Weeks (April-June)

Goals: -Continue strength building
-Use same 4 Core Lifts
-Increase sets/Lower reps
-Lower Volume due to intro. to Plyometrics
-Drop Supplemental Exercises
-Add Stadium Steps(2 Sets)

MUSCULAR STRENGTH:

4 Core Lifts:	3 x Week
Power Clean	5x5 @90% 1RM
Bench Press(Incline)	
Squat/Shoulder Press/Neck Exercises	

ENERGY/CARDIOVASCULAR FITNESS:

AEROBIC(1 x Week)
Jog 880
4x440-Jog/Walk 220
1.5 Mile Run
Jump Rope
Sit-ups/Push-ups(same)

ANAEROBIC(2 x Week)
2 x 40,60,100yd.sprints
(45 sec. rest intervals)
Sled Pulls

PLYOMETRICS(3x10)
Push-ups(Claps)
Power Hops
Medicine Ball Throws
Squat Jumps

PRE-SEASON CYCLE: 8 Weeks (July/August)

Goals: -Focus on Sport Specific Exercise
-Add 3 sets/fast reps(15-25) 1 x Week
-Add 3 sets 1-3 rep max.
-Concentrate completely on anaerobic metabolism
(Increase to 4 x Week)

MUSCULAR STRENGTH:
4 Core Lifts: -2 x Week 50%RM 3x15-25 Fast rep/All out
Power Cleans -1 x Week 90%RM 3x1-3 rep/max
Bench Press(Incline)
Squat
Shoulder Press
**Neck Exercises

ENERGY/CARDIOVASCULAR FITNESS:
NO AEROBIC WORKOUT

ANAEROBIC

Day 1: Jog 440
Sled Pulls
Jump Rope
Sit-ups/Push-ups

Day 2&3: Sprints 5 x 100,60,40(35 sec rest)
(1.5 min. rest between sets)

Day 3: Same as Day 1
Add 2 x Stadium Steps/Grass Drills

IN-SEASON CYCLE: September-December/January

Goals: -Concentrate on maintenance work
-Add anaerobic work into practice

MUSCULAR STRENGTH:

MAINTENANCE PROGRAM

4 Core Lifts:	1 x Week 2x5 @90% 1RM
Power Cleans	1 x Week 2x1 Max.
Squat	1 x Week 1x10 @60% 1RM
Bench Press(Incline)	
Shoulder Press	
**Neck Exercises	

ENERGY/CARDIOVASCULAR FITNESS:

Plyometrics added into practice Drills
Drop Jump Push/Pulls Fire Block

ANAEROBIC
Sled Drive Work(1 x Week)
Grass Drills
Explosion Start Work

WARM-UP EXERCISES	COOL DOWN EXERCISES
440 Jog/Form Running	440 Jog/Form Reading
Jumping Jacks	Jumping Jacks
Squat Thrusts	Back & Hips
Chest/Shoulder Stretch	Seated Straddle Groin Stretch

Roundhouse Kick

The strength and conditioning program for the karate roundhouse kick involves four phases: hypertrophy, basic strength, power, and maintenance. The goals of the program are to increase force production and speed in punches, kicks, and blocks, increase endurance, and increase size.

Hypertrophy Phase

The purpose of the hypertrophy phase is to increase lean body mass while decreasing the total amount of fat(Hobusch & McClellan,1990). The total volume is relatively high and the training emphasis is conditioning.

Monday/Thursday(3x10)	Tuesday/Friday(3x10)
Dumbbell squat	Close-grip bench press
Squat	Dumbbell bench press
Leg extension	Chin-up
Hip flexion	Pull-up
Leg curl	Bent-over lateral raise
Hip extension	Lying tricep extension
Hip adduction/abduction	Barbell curl

Power Phase

During the power cycle, the athlete performs circuits that are more sport specific than during the hypertrophy cycle. Three to five minute intervals between sets allow the athlete to increase his anaerobic capacity.

Monday Circuit (3x5)	Wednesday Circuit (3x5)	Friday Circuit (3x5)
Dumbbell bench press	Lat Pulldown	Bench press
Hip flexion	Hip adduction	Hip flexion
Bent-over row	Lateral raise	Chin-up
Hip extension	Hip abduction	Hip extension
Leg extension	Neck machine	Leg extension
Leg curl	Plate pass	Leg curl

Peaking Phase

The phase nearest the major competitive event is the Peaking phase. The athlete works out three to four times per week to allow for recovery. Volume and intensity are reduced two weeks before competition which lessens the chance of overtraining.

Monday/Thursday
(2x6)
Power clean
Leg press

Circuit:
- Reverse grip bench press
- Leg extension
- Dumbbell row
- Leg curl
- Neck machine

Tuesday/Friday
(2x6)
Power clean
Squat

Circuit:
- Bench press
- Chin-up

Hip flexion
- Leg extension
- Leg curl

Vertical Jump

The strength and conditioning program for vertical jumping involves working the entire body and concentrates on plyometrics and power drills. Free weights are used during the program for added balance and stability.

The program consists of three phases:

Phase I: (3-5 weeks) Strength is the goal in this phase with less emphasis on plyometrics.

Phase II: (3-5 weeks) Same strength goals as in Phase I with more concern in plyometrics.

Phase III: (3-5 weeks) Plyometrics is the main consideration with less emphasis on strength gain.

The same exercises are used throughout the program with an increase in the amount of repetitions from Phase I to Phase III. There are three workouts per week to allow for adequate rest.

Phase I	Phase II	Phase III
Squat 3x6	Squat 3x8	Squat 2x10
Bench press 3x6	Bench press 3x8	Ben. Press 2x10
Leg extension 3x15	Leg extension 3x15	Leg ext. 2x15
Leg curl 3x15	Leg curl 3x15	Leg curl 2x15
Military press 3x6	Military press 3x8	Mil. press 2x10
Lateral raise 3x10	Lateral raise 3x12	Lat. raise 2x12
Barbell curl 3x6	Barbell curl 3x8	B.B. curl 2x10
Lying ext. 3x6	Lying ext. 3x8	Lying ext. 2x10

Plyometrics:

Push-ups(claps)1x10	Push-ups(claps)2x10	Push-ups 3x10
Squat jumps 1x10	Squat jumps 2x10	Squat jumps 3x10
Power hops 1x10	Power hops 2x10	Power hops 3x10
Vertical jump 2x10	Vertical jump 3x10	Vertical jump 4x10

Rope Jumping

The benefits of rope jumping in terms of improved agility and coordination can be expanded to include cardiovascular fitness when it is incorporated into a general athletic strength and conditioning program(Pitreli & O'Shea,1986). It provides a rhythmic exercise for the heart during heavy strength training, while it offsets valsalvic maneuvers imposed upon the heart by heavy squatting and bench pressing.

GENERAL ATHLETIC TRAINING CYCLE:

Warm up: Rope jumping 5 minutes
Core Exercises:

1)Power cleans	3x8
Rope jumping	2 minutes
Rest	2 minutes
2)Squat	3x10
Rope jumping	2 minutes
Rest	2 minutes
3)Bench press	3x10
Rope jumping	2 minutes
Rest	5 minutes

Mini Weight Circuit

Arm curls	10-12 repititions
Tricep extension	10-12
Dumbbell front raise	10-12
Leg curl	10-12
Rope jumping	2 minutes
Rest	2 minutes

Repeat circuit 2-4 times using a variety of weight exercises (Pitreli & O'Shea,1986)

STRENGTH and POWER CYCLE

Warm-up:Rope jump for 3 minutes

Core Exercises:

1)Bench or Incline press 3-4x4-6
Rope jump 1 minute
Rest 2 minutes

2)Power clean 3-4x4-6
Rope jump 1 minute
Rest 2 minutes

3)Squats 3-4x4-6
Rope jump 1-2 minutes
Rest 5 minutes

4)Start auxillary workout-sport specific exercises and every third exercise rope jump for 1 minute.

5)At the conclusion of the workout cool down with 2-3 minutes of rope jumping.

CONCLUSION

The majority of the kinesiological results of this study were similar to that of other existing research. All four techniques were performed as closely as possible to the techniques used in other research studies. These similarities enabled closer comparisons of the respective results. Any differences in kinesiological analysis results was probably due to slight variations in the performance of skills.

A thorough biomechanic analysis of any skill can get extremely complex and tedious which was far beyond the scope of this study, therefore the biomechanical analysis of the skills only touched on specific aspects of the performances which may spur ideas for further research. Through the use of the kinesiological and biomechanical analysis of the long snap, karate kick, vertical jump, and jump roping a strength and conditioning program was formulated to meet the conditioning needs of these specific skills within their respective sports.

This study may have introduced new ideas for future biomechanic research but also reinforced existing research in these sport specific areas.

REFERENCES

Brancazio,P.J.(1994). Sport Science: Physical Laws and Optimum Performance New York:Simon and Schuster.

Hay,J.G.(1993). The Biomechanics of Sports Techniques (4th ed.). Englewood Cliffs:Prentice Hall.

Hobusch,F.L. & McClellan(1990). The karate roundhouse kick. National Strength and Conditioning Association Journal,12(6),5-9,84-89.

Ohton.D.(1988). A kinesiological look at the long snap in football. National Strength and Conditioning Journal,10(1), 4-13.

Pitreli,J. & O'Shea,P.(1986). Rope jumping: The biomechanics, techniques of an application to athletic conditioning. National Strength and Conditioning Journal,8(4),5-11,60-61.

Semenick,D.M. & Adams,K.O.(1987). The vertical jump: a kinesiological analysis with recommendations for strength and conditioning programming. National Strength and Conditioning Journal,9(3),5-9.

BIOMECHANICAL AND KINESIOLOGICAL BIBLIOGRAPHY

Abourezk, T., Toole, T. (1995). Effect of task complexity on the relationship between physical fitness and reaction time in older women. Journal of Aging and Physical Activity, 3, 251-260.

Aitkens, S., Lord, J., Bernauer, E., Fowler, W. M., Lieberman, J. S., Berck, P. (1989, March). Relationship of manual muscle testing to objective strength measurements. Muscle & Nerve, 12, 173-177.

Bejjani, F. J., Halpern, N., Pio, A., Dominguez, R., Voloshin, A., Frankel, V. H. (1988, April). Musculoskeletal demands on flamenco dancers: a clinical and biomechanical study. American Orthopaedic Foot and Ankle Society, Inc., 8 (5), 254-263.

Blevins, F. T., Hecker, A. T., Bigler, G. T., Boland, A. L., Hayes, W. C. (1994). The effects of donor age and strain rate on the biomechanical properties of bone-patellar tendon-bone allografts. The American Journal of Sports Medicine, 22 (3), 328-333.

Cameron, D. M., Bohannon, R. W. (1993, May). Relationship between active knee extension and active straight leg raise test measurements. Journal of Sports Physical Therapy, 17 (5), 257-259.

Caster, B. L., Bates, B. T. (1995). The assessment of mechanical and neuromuscular response strategies during landing. Medicine and Science in Sports and Exercise, 27 (5), 736-744.

Chen, C. (1993, August). Biomechanics of Ocular Pneumoplethysmography. Journal of Biomechanical Engineering, 115, 231-238.

Colville, M. R., Marder, R. A., Zarins, B. (1992). Reconstruction of the lateral ankle ligaments. The American Journal of Sports Medicine, 20 (5), 594-599.
Dufek, J. S., Bates, B. T. (1991). Dynamic performance assessment of selected sport shoes on impact forces. Medicine and Science in Sports Exercise, 23 (9), 1062-1067.

Garg, A., Walker, P. S. (1990). Prediction of total knee motion using a three-dimensional computer-graphics model. Journal of Biomechanics, 23 (1), 45-58.

Ghena, D. R., Kurth, A. L., Thomas, M., Mayhew, J. (1991, October). Torque characteristics of the quadriceps and hamstring muscles during concentric and eccentric loading. Journal of Sports Physical Therapy, 14 (4), 149-153.

Graham, V. L., Gehlsen, G. M., Edwards, J. A. (1993). Electromyographic evaluation of closed and open kinetic chain knee rehabilitation exercises. Journal of Athletic Training, 28 (1), 23, 26-30.

Hainaut, K., Duchateau, J. (1989, August). Muscle fatigue, effects of training and disuse. Muscle & Nerve, 12, 660-669.

Halverson, L. E., Roberton, M. A., Langendorfer, S. (1982). Development of the overarm throw: movement and ball velocity changes by seventh grade. Research Quarterly for Exercise and Sport, 53 (3), 198-205.

Heise, G. G. (1994). Segment interactions of the arm during the practice of a novel, multijoint throwing skill. Journal of Applied Biomechanics, 10, 352-373.

Hoffman, M., Payne, V. G. (1995, February). The effects of proprioceptive ankle disk training on healthy subjects. Journal of Sports Physical Therapy, 21 (2), 90-93.

Hollis, J. M., Blasier, R. D., Flahiff, C. M., Hofmann, O. E. (1995). Biomechanical comparison of reconstruction techniques in simulated lateral ankel ligament injury. The American Journal of Sports Medicine, 23 (6), 678-682.

Kralj, A., Jaeger, R. J., Munih, M. (1990). Analysis of standing up and sitting down in humans: definitions and normative data presentation. Journal of Biomechanics, 23 (11), 1123-1138.

Kuramoto, A. K., Payne V. G. (1995, June). Predicting muscular strength in women: a preliminary study. Research Quarterly for Exercise and Sport, 66 (2), 168-172.

Lundin, T. M., Feuerbach, J. W., Grabiner, M. D. (1993). Effect of plantar flexor and dorsiflexor fatigue on unilateral postural control. Journal of Applied Biomechanics, 9, 191-201.

Martens, D., Butterfield, S. A., Lehnhard, R. A. (1996, Winter). A kinematic analysis of a static balance task by children who are deaf. Clinical Kinesiology, 106-110.

McGrain, P., Van Dyke, J., Mastro, J. (1987). Coefficients of restitution of balls used in team sports for the visually impaired. International Journal of Sport Biomechanics, 3, 63-68.

(SPORT SPECIFIC)

Baseball

Bramhall, J. P. (1992, April). Mechanical failure. Athletic Business, 9-10.

DeRenne, C., Buxton, B. P., Hetzler, R. K., Ho, K. W. (1995). Effects of weighted bat implement training on bat swing velocity. Journal of Strength and Conditioning Research,9 (4), 247-250.

Dillman, C. J., Fleisig, G. S., Andrews, J. R. (1993). Biomechanics of pitching with emphasis upon shoulder kinematics. Journal of Sports Physical Therapy, 18 (2), 402-408.

Elliott, B., Grove, J. R., Gibson, B., Thurston, B. (1986). A three-dimensional cinematographic analysis of the fastball and curveball pitches in baseball. International Journal of Sport Biomechanics 2, 20-28.

Fleisig, G. S., Andrews, J. R., Dillman, C. J., Escamilla, R. F. (1995). Kinetics of baseball pitching with implications about injury mechanisms. The American Journal of Sports Medicine, 23 (2), 233-239.

McIntyre, D. R., Pfautsch, E. W. (1982). A kinematic analysis of the baseball batting swings involved in opposite-field and same-field hitting. Research Quarterly for Exercise and Sport, 53 (3), 206-213.

Mikesky, A. E., Edwards, J.E., Wigglesworth J. K., Kunkel, S. (1995). Eccentric and concentric strength of the shoulder and arm musculature in collegiate baseball pitchers. The American Journal of Sports Medicine, 23 (5), 638-642.

Simpson, B. (1991, January). Bats! pick one wisely. Scholastic Coach, 96-97, 106.

Welch, C. M., Banks, S. A., Cook, F. F., Draovitch, P. (1995, November). Hitting a baseball: a biomechanical description. Journal of Sports Physical Therapy, 22 (5), 193-201.

Werner, S. L., Fleisig, G. S., Dillman, C. J., Andrews, J. R. (1993). Biomechanics of the elbow during baseball pitching. Journal of Sports Physical Therapy, 17 (6), 274-278.

Basketball

Ball, R. (1989). The basketball jump shot: a kinesiological analysis with recommendations for strength and conditioning programs. National Strength and Conditioning Association Journal, 11 (5), 4-12.

McClay, I. S., Robinson, J. R., Andriacchi, T. P., Frederick, E., Gross, T., Martin, P., Valiant, G., Williams, K. R., Cavanagh, P. R. (1994). A kinematic profile of skills in professional basketball players. Journal of Applied Biomechanics, 10, 205-221.

McClay, I. S., Robinson, J. R., Andriacchi, T. P., Frederick, E. C., Gross, T., Martin, P., Valiant, G., Williams, K. R., Cavanagh, P. R. (1994). A profile of ground reaction forces in professional basketball. Journal of Applied Biomechanics, 10, 222-236.

Shambaugh, J. P., Klein, A., Herbert, J. H. (1990). Structural measures as predictors of injury in basketball players. Official Journal of the American College of Sports Medicine, 522-526.

Cycling

Ruby, P., Hull, M. L., Kirby, K. A., Jenkins, D. W. (1992). The effects of lower-limb anatomy on knee loads during seated cycling. The Journal of Biomechanics, 25 (10), 1195-1207.

Too, D. (1994). The effect of trunk angle on power production in cycling. Research Quarterly for Exercise and Sport, 65 (4), 308-315.

Dance and Aerobics

Chmelar, R. D., Shultz, B. B., Ruhling, R. O., Fitt, S. S., Johnson, M. B. (1988). Isokinetic characteristics of the knee in female, professional and university, ballet and modern dancers. Journal of Orthopaedic and Sports Physical Therapy, 9 (12), 410-418.

Francis, P., Francis, L. (1989, July/August). High-and low-impact aerobics. Idea Today, 56-60.

Michaud, T. J., Rodriguez-Zayas, J., Armstrong, C., Harting, M. (1993). Ground reaction forces in high impact and low impact aerobic dance. The Journal of Sports Medicine and Physical Fitness, 33 (4), 359-366.

Gymnastics

Bruggemann, G. P., Cheetham, P. J., Alp, Y., Arampatzis, D. (1994). Approach to a biomechanical profile of dismounts and release-regrasp skills of the high bar. Journal of Applied Biomechanics, 10 (3), 291-312.

Gervais, P., Tally, Francis. (1993). The beat swing and mecahnical descriptors of three horizontal bar release-regrasp skills. Journal of Applied Biomechanics, 9 (1), 66-83.

Housh, T. J., Johjnson, G. O., Housh, D. J., Weir, J. P., Weir, L. L., Eckerson, J. M., Stout, J. R. (1996). Age, fat-free weight, and isokinetic peak torque in high school female gymnasts. Medicine and Science Sports Exercise, 28 (5), 610-613.

Prassas, S. (1991). Mechanics of the straight arms/straight body press handstand. Journal of Human Movement Studies, 20 (1), 1-13.

Takei, Y., Nohara, H., Kamimura, M. (1992). Techniques used by elite gymnasts in the 1992 olympic compulsory dismount from the horizontal bar. International Journal of Sport Biomechanics, 8, 207-232.

Raquet Sports

Behm, D. G. (1987). A kinesiological analysis of the squash stroke. National Strength and Conditioning Association Journal, 9 (5), 4, 6-14.

Behm, D. (1988). A kinesiological analysis of the tennis service. National Strength and Conditioning Association Journal, 10 (5), 4, 6-14.

Hatze, H. (1992). Objective biomechanical determination of tennis racket properties. International Journal of Sport Biomechanics, 8, 275-287.

Lo, D., Stark, K. (1991). The badminton overhead shot. National Strength and Conditioning Association Journal, 13 (4), 6-13.

Running

Adelaar, R. S. (1986). The practical biomechanics of running. The American Journal of Sports Medicine, 14 (6), 497-500.

Adelizi, D. (1995, Summer). Improving distance running through stride awareness. Track & Field Coaches Review, 95 (2), 25-28.

Bahlsen, A., Nigg, B. M. (1987). Influence of attached masses on impact forces and running style in heel-toe running. International Journal of Sport Biomechanics, 3, 264-275.

Chu, D., Korchemny, R. (1989). Sprinting stride actions: analysis and evaluation. National Strength and Conditional Association Journal, 11 (6), 6-8, 81-85.

Feltner, M. E., Macrae, H. S., Macrae, P. G., Turner, N. S., Hartman, C. A., Summers, M. L., Welch, M. D. (1994). Strength training effects on rearfoot motion in running. Medicine and Science in Sports Exercise, 26 (8), 1021-1027.

Grimston, S. K., Engsberg, J. R., Kloiber, R., Hanley, D. A. (1991). Bone mass, external loads, and stress fracture in female runners. International Journal of Sport Biomechanics, 7, 293-302.

Guissard, N., Duchateau, J., Hainaut, K. (1992, February). EMG and mechanical changes during sprint starts at different front block obliquities. Official Journal of the American College of Sports Medicine, 1257-1263.

Kaneko, M. (1990). Mechanics and energetics in running with special reference to efficiency. Journal of Biomechanics, 23 (1), 57-63.

Kultury, T. P. (1990, September). Lower-extremity strength asymmetry in sprinters. SSR, 107-109.

Lees, A., Bouracier, J. (1994). The longitudinal variability of ground reaction forces in experienced and inexperienced runners. Ergonomics, 37 (1), 197-206.

Mann, R., Sprague, P. (1980). A kinetic analysis of the ground leg during sprint running. Research Quarterly for Exercise and Sport, 51 (2), 334-348.

Marshall, R. N., Paterson, D. J., Glending, P. (1990). Mechanics of prolonged downhill running. International Journal of Sport Biomechanics, 6, 56-66.

McNair, P. J., Marshall, R. N. (1994). Kinematic and kinetic parameters associated with running in different shoes. Br. Journal of Sports Medicine, 28 (4), 256-260.

Nigg, B. M., De Boer, R. W., Fisher, V. (1995). A kinematic comparison of overground and treadmill running. Official Journal of the American College of Sports Medicine, 98-105.

Sailors, M. E., Keskula, D. R., Perrin, D. H. (1995, April). Effect of running on anterior knee laxity in collegiate-level female athletes after anterior cruciate ligament reconstruction. Journal of Sport Physical Therapy, 21 (4), 233-239.

Shorten, M. R., Winslow, D. S. (1992). Spectral analysis of impact shock during running. International Journal of Sport Biomechanics, 8, 288-304.

Sleivert, G. G., Backus, S. R., Wenger, H. A. (1995). Neuromuscular difference between volleyball players, middle distance runners and untrained controls. International Journal of Sports Medicine, 16, 390-398.

Vagenas, G., Hoshizaki, B. (1986). Optimization of an asymmetrical motor skill: sprint start. International Journal of Sport Biomechanics, 2, 29-40.

Williams, K. R., Ziff, J. L. (1991). Changes in distance running mechanics due to systematic variations in running style. International Journal of Sport Biomechanics, 7, 76-90.

Skiing

Atkins, J. W., Hagerman, G. R. (1984, January). Alpine skiing. National Strength Conditioning Association Journal, 6-8.

Berg, H. E., Eiken, O., Tesch, P. A. (1995, April). Involvement of eccentric muscle actions in giant slalom racing. Official Journal of the American College of Sports Medicine, 1666-1670.

Bilodeau, B. B., Rundell, K. W., Roy, B., Boulay, M. R. (1995, September). Kinematics of cross-country ski racing. Official Journal of the American College of Sports Medicine, 128-137.

O'Shea, P. (1987). Nordic skiing--the diagonal stride and ski skating. National Strength Conditioning Association Journal, 9 (6), 4-12.

O'Shea, P. (1990). Ski racing--the giant slalom turn. National Strength Conditioning Association Journal, 12 (1), 4-8, 83-87.

Read, L., Herzog, W. (1992). External loading at the knee joint for landing movements in alpine skiing. International Journal of Sport Biomechanics, 8 (1), 62-80.

Soccer

Anderson, D. I., Sidaway, B. (1994, June). Coordination changes associated with practice of a soccer kick. Research Quarterly for Exercise and Sport, 65 (2), 93-99.

Mognoni, P., Narici, M. V., Sirtori, M. D., Lorenzelli, F. (1994). Isokinetic torques and kicking maximal ball velocity in young soccer players. The Journal of Sports Medicine and Physical Fitness, 34 (4), 357-361.

Pronk, N. P. (1991). The soccer push pass. National Strength and Conditioning Association Journal, 13 (2), 6-8, 77-81.

Rahmatpanah, M. (1994, November). Why ball juggling? Scholastic Coach & Athletic Director, 64 (4), 14, 16.

Wang, J., Wiese-Bjornstal, D. M. (1994, December). Mechanical and anatomical analysis of the soccer instep shot. Strength and Conditioning, 34-38.

Speed Skating

de Boer, R. W., Ettema, J. C., Gorkum, H., de Groot, G., Schenau, G. J. (1987). Biomechanical aspects of push-off techniques in speed skating the curves. International Journal of Sport Biomechanics, 3, 69-79.

de Koning, J. J., de Groot, G., Schenau, G. J. (1989). Mechanical aspects of the sprint start in olympic speed skating. International Journal of Sport Biomechanics, 5, 151-168.

Schenau, V. I., Groot, G. D., Scheurs, A. W., Meester, H., Koning, J. J. (1996). A new skate allowing powerful plantar flexions improves performance. Medicine and Science in Sports Exercise, 28 (4), 531-535.

Swimming and Water Polo

Claude, A. B., Sharp, R. L. (1991). The effectiveness of cycle ergometer training in maintaining aerobic fitness during detraining from competitive swimming. The Journal of Swimming Research, 7 (3), 17-20.

Guth, E. H. (1995). A comparison of cervical rotation in age-matched adolescent competitive swimmers and healthy males. Journal of Sports Physical Therapy, 21 (1), 21-26.

Hinrichs, R. N., McLean, S. P. (1991). A mathematical model of competitive swimming in pools with currents. International Journal of Sport Biomechanics, 7, 163-174.

Kennedy, P., Brown, P., Chengalur, S. N., Nelson, R., C. (1990). Analysis of male and female olympic swimmers in the 100-meter events. International Journal of Sport Biomechanics, 6, 187-197.

Whiting, W. C., Puffer, J. C., Finerman, G. A., Gregor, R. J., Maletis, G. B. (1985). Three-dimensional cinematographic analysis of water polo throwing in elite performers. American Journal of Sports Medicine, 13 (2), 95-98.

Track and Field

Dearmond, R., Semenick, D. M. (1989). The javelin throw: a kinesiological analysis with recommendations for strength and conditioning programming. National Strength and Conditioning Association Journal, 11 (2), 4-7, 77-79.

Baltrusaitis Genuario, S. E., Dolgener, F. A. (1980). The realtionship of isokinetic torque at two speeds to the vertical jump. Research Quarterly for Exercise and Sport, 51 (4), 593-598.

Davis, R., Ferrara, M. (1988). The competitive wheelchair stroke. National Strength and Conditioning Association Journal, 10 (3), 4, 6-10.

Grimshaw, P. N., Marar, L., Salo, A., Knight, G., Vernon, J. (1995). A kinematic analysis of sprint hurdles training strategies (isolation drills) Athletics Coach, 29 (4), 24-28.

Grimshaw, P., Marar, L., Salo, A., Longden, B., Vernon, J. (1995, Summer). Biomechanical analysis of sprint hurdles. Athletics Coach.

Harman, E. A., Frykman, P. N., Rosenstein, R. M. (1991). The effects of arms and countermovement on vertical jumping. National Strength and Conditioning Association Journal, 13 (3), 38-39.

Hay, J. G., Nohara, H. (1989). Techniques used by elite long jumpers in preparation for trakeoff. Journal of Biomechanics, 23 (3), 229-239.

Judge, L. (1996, March). A total program for the emerging discus thrower. Coach and Athletic Director, 28-31.

McFarlane, B. (1986). High performance hurdling--the women's 100m hurdles. National Strength and Conditioning Association Journal, 8 (6), 4-7.

Mero, A., Komi, P., Korjus, T., Navarro, E., Gregor, R. J. (1994). Body segment contributions to javelin throwing during final thrust phases. Journal of Applied Biomechanics, 10, 166- 177.

Morriss, C., Bartlett, R. (1994). Bio-mechanical analysis of the hammer throw. Athletics Coach, 28 (3), 18-20.

Naylor, R. (1994). Photosequence analysis - dalton grant. Athletics Coach, 28 (4), 16-19.

O'Shea, P., Elam, R. (1984, October-November). The shot put--mechanics, techniques, strength and conditioning programs. National Strength and Conditioning Association Journal, 4-5, 74-79.

Paulsen, R. (1986, April). Modern rotational style of putting. Scholastic Coach, 55 (9), 38-40, 49, 10.

Ross, W. (1982, March). Form analysis of edwin moses. Scholastic Coach, 34-35, 44.

Schweigert, D. (1992). Dynamic high jumping. Track and Field Quarterly Review, 4, 39-42.

Semenick, D. M., Adams, K. O. (1987). The vertical jump: a kinesiological analysis with recommendations for strength and conditioning programming. National Strength and Conditioning Association Journal, 9 (3), 5-8.

Stewart, G. (1975, June). Flexibility training for the decathlete. Yessis Review, 10 (2), 20-24.

Voroblev, A., Ter-Ovanessian, I., Ariel, G. (1992, Winter). Two world's best long jumps: comparative biomechanical analysis. Track and Field Quarterly Review, 9 (4), 6-10.

Volleyball

Demerchant, R. (1995, August). A chip off the old block - How to teach everyone to hit around the block or to "wipe" off it. Scholastic Coach, 65 (1), 44-46.

Demerchant, R. (1995, September). Developing the attacker - Any time a skill isn't taught or practiced, it won't magically appear in a game. Scholastic Coach, 65 (2), 70, 72-73.

Weight Training

Barnett, C., Kippers, V., Turner, P. (1995). Effects of variations of the bench press exercise on the emg activity of five shoulder muscles. Journal of Strength and Conditioning Research, 9 (4), 222-227.

Bielik, E. (1985). Sports performance series: long jump--analysis and in-weightroom speed-strength program. National Strength and Conditioning Association Journal, 7 (3), 4-6, 75-76, 78-80.

Burdett, R. (1982). Biomechanics of the snatch technique of highly skilled and skilled weightlifters. Research Quarterly for Exercise and Sport, 53 (3), 193-197.

Canavan, P. K., Garrett, G. E., Armstrong, L. E. (1996). Kinematic and kinetic relationship between an olympic-style lift and the vertical jump. Journal of Strength and Conditioning Research, 10 (2), 127-130.

Derwin, B. P. (1990). Sports performance series: the snatch: technical description and periodization program. National Strength and Conditioning Association Journal, 12 (2), 6, 8-14, 80-81.

Garhammer, J. (1984, June-July). Bridging the gap: power clean - kinesiological evaluation. National Strength and Conditioning Association Journal, 16-19.

Hakkinen, K. (1988). A biomechanical analysis of various combinations of the snatch pull exercise. Journal of Human Movement Studies, 15, 229-243.

Hattin, H. C., Pierrynowski, M. R., Ball, K. A. (1989). Effect of load, cadence, and fatigue on tibio-femoral joint force during a half squat. Medicine and Science in Sports and Exercise, 21 (5), 613-618.

Holcomb, W. R., Lander, J. E., Rutland, R. M., Wilson, G. D. (1996). A biomechanical analysis of the vertical jump and three modified plyometric depth jumps. Journal of Strength and Conditioning Research, 10 (2), 83-88.

Holcomb, W. R., Lander, J. E., Rutland, R. M., Wilson, G. D. (1996). The effectiveness of a modified plyometric program on power and the vertical jump. Journal of Strength and Conditioning Research, 10 (2), 89-92.

Mayhew, J. L., Prinster, J. L., Ware, J. S., Zimmer, D. L., Arabas, J. R., Bemben, M. G. (1995, June). Muscular endurance repetitions to predict bench press strength in men of different training levels. The Journal of Sports Medicine and Physical Fitness, 35 (2), 108-113.

Monte, A. D., Leonardi, L. M., Menchinelli, C., Marini, C. (1987). A new bicycle design based on biomechanics and advanced technology. International Journal of Sport Biomechanics,3, 287-292.

Schipplein, O. D., Trafimow, J. H., Andersson, B. J., Andriacchi, T. P. (1990). Relationship between moments at the L5/S1 level, hip and knee joint when lifting. Journal of Biomechanics, 23 (9), 907-912.

Shirley, M. E. (1992). Sports Performance Series: the taekwondo side kick: a kinesiological analysis with strength and conditioning principles. National Strength and Conditioning Association Journal,14 (5), 7-8, 72-78.

Wagner, L. L., Evans, S. A., Weir, J. P., Housh, T. J., Johnson, G. O. (1992). The effect of grip width on bench press performance. International Journal of Sport Biomechanics, 8, 1-10.

Wilson, G. J., Elliott, B. C., Kerr, G. K. (1989). Bar path and force profile characteristics for maximal and submaximal loads in the bench press. International Journal of Sport Biomechanics, 5, 390-402.

Wretenberg, P., Feng, Y., Arborelius, U. P. (1996). High-and low-bar squatting techniques during weight-training. Official Journal of the American College of Sports Medicine, 218-224.

Yessis, M. (1992, July). Kinesiology muscles - finger flexion. Muscle & Fitness, 124-125, 219.

Yessis, M. (1992, August). Kinesiology muscles - good morning. Muscle & Fitness, 60-61, 260.

Yessis, M. (1992, September). Kinesiology muscles - hack squat. Muscle & Fitness, 58-59, 238-239.

Yessis, M. (1993, December). Kinesiology muscles in motion - lying trunk twist. Muscle & Fitness, 64-65.

Yessis, M. (1995, January). Kinesiology muscles in motion - standing leg curl. Muscle & Fitness, 56-57.

Yessis, M. (1995, April). Kinesiology muscles in motion - the side lunge. Muscle & Fitness, 100-101, 271.

Yessis, M. (1995, May). Kinesiology muscles in motion - hanging leg raise. Muscle & Fitness, 96-98.

Yessis, M. (1995, September). Dumbbell shoulder shrug. Muscle & Fitness, 60-61, 206,210.

Yessis, M. (1995, November). Kinesiology muscles in motion - seated row. Muscle & Fitness, 60-61, 198.

Yessis, M. (1995, December). Kinesiology muscles in motion - the front raise. Muscle & Fitness, 46-47, 49.

Yessis, M. (1996, February). Kinesiology muscles in motion - pull-up. Muscle & Fitness, 54-55, 57.

Yessis, M. (1996, March). Kinesiology muscles in motion - the hack squat. Muscle & Fitness, 56-58.

Yessis, M. (1996, April). Kinesiology muscles in motion - standing cable crossover. Muscle & Fitness, 48-50.

Yessis, M. (1996, April). Kinesiology muscles in motion - plyometrics. Muscle & Fitness, 81-82, 84, 208.

Yessis, M. (1996, May). Kinesiology muscles in motion - the upright row. Muscle & Fitness, 46-48.

Miscellaneous Sports

Water skiing, field hockey, rowing, golf, windsurfing, rugby, handball, ice hockey, football, wrestling, tennis and archery.

Blackwell, J. R., Cole, K. J. (1994). Wrist kinematics differ in expert and novice tennis players performing the backhand stroke: implications for tennis elbow. Journal of Biomechanics, 27 (5), 509-516.

Eberhardt, T. (1988). Sports performance series: an anatomical description of the slalom turn in water skiing and how to condition for this sport. National Strength and Conditioning Association Journal, 10 (6), 4-9.

Emmert, W. (1984, April-May). Sports performance series: the slap shot--strength and conditioning program for hockey at boston college. National Strength and Conditioning Association Journal, 4-6, 68, 71, 73.

Fenety, A., Kumar, S. (1992, September). Isokinetic trunk strength and lumbosacral range of motion in elite female field hockey players reporting low back pain. Journal of Sport Physical Therapy, 16 (3), 129-135.

Groppel, J. L., Nirschl, R. P. (1986). A mechanical and electromyographical analysis of the effects of various joint counterforce braces on the tennis player. The American Journal of Sports Medicine, 14 (3), 195-200.

Groppel, J. L., Shin, I. S., Thomas J. A., Welk, G. J. (1987). The effects of string type and tension on impact in midsized and oversized tennis racquets. International Journal of Sport Biomechanics, 3, 40-46.

Jacobson, B. (1983, October-November). Kinesiological analysis: wrestling--the single-leg takedown. National Strength and Conditioning Association Journal, 6-8, 71.

Joris, H. J. J., Van Muyen, A. J., Van Ingen Schenau, G. J., Kemper, H. C. G. (1985). Force, velocity and energy flow during the overarm throw in female handball players. Journal of Biomechanics, 18 (6), 409-414.

Justice, T. (1990). Sports performance series: the wrestling waist and arm throw. National Strength and Conditioning Association Journal, 12 (3), 6-9, 82-88.

Maddalozzo, G. F. (1987). Sports performance series: an anatomical and biomechanical analysis of the full golf swing. National Strength and Conditioning Association Journal, 9 (4), 6-8, 78-79.

Mazzone, T. (1988). Sports performance series: kinesiology of the rowing stroke. National Strength and Conditioning Association Journal, 10 (2), 4, 6-11.

Milburn, P. D. (1990). The kinetics of rugby union scrummaging. Journal of Sports Science, 8 47-60.

Olson, J. R. (1986). Sports performance series: an anatomic analysis of football punting with implications for conditioning. National Strength and Conditioning Associaton Journal, 8 (2), 5-6, 8-9.

Renfro, G. J. (1992). Sports performance series: the archer's draw. National Strength and Conditioning Association Journal, 14 (6), 6-8, 74-75.

Sanders, R. H., Owens, P. C. (1992). Hub movement during the swing of elite and novice golfers. International Journal of Sport Biomechanics, 8, 320-330.

Strong, J. (1987, April). Developing the defensive back's technique. Scholastic Coach, 35-37.

Stuart, J., Atha, J. (1990). Postural consistency in skilled archers. Journal of Sports Sciences, 8,223-234.

Van Gheluwe, B., Huybrechts, P., Deporte, E. (1988). Electromyographic evaluation of arm and torso muscles for different postures in windsurfing. International Journal of Sport Biomechanics, 4, 156-165.

Watson, A. W. S. (1995, December). Sports injuries in footballers related to defects of posture and body mechanics. The Journal of Sports Medicine and Physical Fitness, 35 (4), 289-293.

Wells, R. P., Bishop, P. J., Stephens, M. (1987). Neck loads during head-first collisions in ice hockey: experimental and simulation results. International Journal of Sport Biomechanics, 3, 432-442.

Myrer, J. W., Draper, D. O., Durrant, E. (1994). Contrast therapy and intramuscular temperature in the human leg. Journal of Athletic Training, 29 (4), 318-322.

Nabors, E. D., Richmond, J. C., Vannah, W. M., McConville, O. R. (1995). Anterior cruciate ligament graft tensioning in full extension. The American Journal of Sports Medicine, 23 (4), 488-492.

Pipes, T. V. (1994, March). Strenght training & fiber types. Scholastic Coach, 67-70.

Prietto, C. A., Caiozzo, V. J. (1989). The in vivo force-velocity relationship of the knee flexors and extensors. The American Journal of Sports Medicine, 17 (5), 607-611.

Putnam, C. A. (1991). A segment interaction analysis of proximal-to-distal sequential segment motion patterns. Medicine and Science in Sports and Exercise, 23 (1), 130-141.

Rhodes, M. (1996, January/February). Balance: give yourself a sporting chance by focusing on proper alignment. Women's Sports & Fitness, 44-46, 48-49.

Salathe, E. P., Jr., Arangio, G. A., Salathe, E. P. (1990). The foot as a shock absorber. Journal of Biomechanics, 23 (7), 655-659.

Signorile, J. F., Kwiatkowski, K., Caruso, J. F., Robertson, B. (1995). Effect of foot position on the electromyographical activity of the superficial quadriceps muscles during the parallel squat and knee extension. Journal of Strength and Conditioning Research, 9 (3), 182-187.

Stacoff, A., Steger, J., Stussi, E., Reinschmidt, C. (1996). Lateral stability in sideward cutting movemer'. Medicine and Science in Sports Exercise,28 (3), 350-358.

Steinkamp, L. A., Dillingham, M. F., Markel, M. D., Hill, J. A., Kaufman, K. R. (1993). Biomechanical considerations in patellofemoral joint rehabilitation. The American Journal of Sports Medicine, 21 (3), 438-441, 443-444.

Torner, M., Almstrom, C., Karlsson, R., Kadefors, R. (1994). Working on a moving surface--a biomechanical analysis of musculo-skeletal load due to ship motions in combination with work. Ergonomics, 37 (2), 345-362.

Tuckman, A. S., Werner, F. W., Fortino, M. D., Spadaro, J. A. (1992). A technique for measuring absolute toe pressures: evaluation of pressure-sensitive film techniques. Foot and Ankle, 13 (4), 220-223.

Verbrugge, J. D. (1996). The effects of semirigid air-stirrup bracing vs, adhesive ankle taping on motor performance. Journal of Sports Physical Therapy, 23 (5), 320-324.

Voloshin, A. S., Bejjani, F. J., Halpern, M., Frankel, V. H. (1989). Dynamic loading on flamenco dancers: a biomechanical study. Human Movement Science, 8, 503-513.

Zavatsky, A. B., Beard D. J., O'Connor, J. J. (1994). Cruciate ligament loading during isometric muscle contractions. The American Journal of Sports Medicine, 22 (3), 418-423.